Bone Densitometry
How to dictate a DEXA

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University of California School of Medicine
San Diego, California
DEXA References
For Reference
CPT codes for DEXA

- 77085 / 77080 Axial skeleton (hips, pelvis, spine) including vertebral fracture assessment
- 77081 Peripheral DEXA forearm
- 77086 Vertebral fracture assessment - DXA
- 77082 Instant Vertebral Assessment IVA
Osteoporosis is the most common metabolic bone disorder. It has been defined by the National Institutes of Health as an age-related disorder characterized by decreased bone mass and increased susceptibility to fractures in the absence of other recognizable causes of bone loss.
Osteoporosis

- Risk factors
  - may be superimposed upon either involutional or secondary osteoporosis, including:
    - Smoking
    - Alcohol
    - Poor diet
    - Lack of exercise
    - An early menopause
    - Strong family history
    - Small frame
Osteoporosis

• The normal rate of bone loss is 2% per year, hence 20-40% of the female bone mass is already lost by the age of 65 years of age, beginning before the menopause and accelerating during and afterwards.
Osteoporosis

- **Bone mass** is the major determinant of bone strength that can be measured by non-invasive techniques, and accounts for 75-85% of this parameter.
DEXA

DEXA has very high 

**accuracy**

(the difference in the measurement from a known standard)

and

**precision**

(observed deviation of serial measurements with time)

both short and long term
to within 1% at the hip and spine
DEXA

- DEXA is at present the most precise measurement of BMD
- QCT is more sensitive to change
DEXA

- DEXA effective dose 1 μSv
- Fracture risk doubles with every SD drop in BD
- \( T \text{ score} = \text{Patient BMD} - \text{Young adult mean BMD} \)
  
  \[ 1 \text{ SD of young adult} \]
Find out as much relevant information as possible

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Pre or Peri/PostMenopausal</th>
</tr>
</thead>
</table>

**Bone Density Clinical Information Sheet**

**Circle Correct Responses**

<table>
<thead>
<tr>
<th>Name(Label)</th>
<th>Sex: M or F</th>
<th>(Premenopausal)</th>
<th>(Perimenopausal)</th>
<th>(Postmenopausal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Preventive Replacement Therapy? | N | Y |
| Preventive treatment for osteoporosis? | N | Y | See over |
| Previous Surgery: | | |
| - Spine? | N | Y | right |
| - Hips? | N | Y | left |
| Uterus/Ovaries? | N | Y |
| Previous Scans | When? | Where? |

**Risk Factors**

| Previous Fractures | N | Y | Where? |
| Family History Osteoporosis | N | Y |
| Medication Steroids | N | Y |
| For Epilepsy | N | Y | Which drug? |
| For Thyroid | N | Y | Which drug? |
| Dietary Calcium | High | Low |
| Cigarette Smoking | N | Y |
| Known Bowel Disease(diarrhoea) | N | Y | Diagnosis? |
| Other Medical Condition | N | Y | List |
Bone densitometry drug sheet

Drugs that may cause osteoporosis

- Corticosteroids
  - Dilantin
  - Diuretics
- Methotrexate
- Thyroxine
- Heparin
- Depomedroxyprogesterone acetate
- Gonadotrophin releasing hormone agonists
- Cyclosporin

Drugs to treat osteoporosis

- HRT: Estrogen
- (SERMS): Raloxifene (Evista)
- Calcitonin: (Nasal spray) Miacalcin
- Bisphosphonates: Alendronate (Fosamax)
  - Etidronate (Didronel)
  - Risedronate (Actonel)
  - Ibandronate
  - Pamidronate (Aredia)
- Others: Combinations, Thiazides, Fluoride, PTH, Growth Hormone, Bicarbonate, Active Vitamin D

Find out as much relevant information as possible
DEXA Dictation

- In Fluency
- Templates
- Find Templates
- Owner
- Hughes, Tudor
- Modality – DEXA
- Body Part – ALL
- Insert
In the setting of a patient with a lumbar spine that cannot be interpreted due to surgical or degenerative reasons, a follow up scan of the radius 33% CPT code 77081 is recommended in addition to the hips.

10 year probability of fracture:

- Major osteoporotic: []%
- Hip: []%
- Population: USA (Caucasian)

Based on DualFemur (left) neck BMD
DEXA Locations

- Two locations

Bone Density Diagnostic Center
Dept. of Radiology, UCSD Medical Center
330 Lewis Street, Suite 202  San Diego, CA 92103
Phone (619 47)19240

Rebecca and John Moores UCSD Cancer Center
3855 Health Sciences Dr. Rm 1220
La Jolla, CA 92039
Phone (858 82) 26121

TECHNIQUE:

[Moores: General Electric Lunar Prodigy Advance.]
[Lewis: General Electric Lunar Prodigy.]
Bone Densitometry
DEXA spine check list

• Note the age, sex, ethnicity and weight
• Does this match the reference ranges?
• Is the bottom of L4 roughly at the level of the iliac crests.
• Are there any ribs on L1
• Scoliosis
• Are the vertebrae correctly divided
• Anything in the soft tissue

Birth Date: 10/17/1980 27.0 years
Height / Weight: 59.0 in. 130.0 lbs.
Sex / Ethnic: Male Hispanic
Referring Physician: YUNG,GORDON
Analysed: 10/30/2007 9:25:59 AM (11.40)
Bone Densitometry
DEXA spine check list

- Note the age, sex, ethnicity and weight
- Does this match the reference ranges?
- Is the bottom of L4 roughly at the level of the iliac crests
- Are there any ribs on L1
- Scoliosis
- Are the vertebrae correctly divided
- Anything in the soft tissue
Transitional vertebrae

Wrong levels
Normal study
Normal Study

Ancillary results

<table>
<thead>
<tr>
<th>Height / Weight:</th>
<th>61.0 in. 150.0 lbs.</th>
<th>Measured:</th>
<th>06/29/2016 10:13:55 AM (13.60)</th>
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</thead>
<tbody>
<tr>
<td>Sex / Ethnic:</td>
<td>Female Asian</td>
<td>Analyzed:</td>
<td>06/29/2016 10:19:00 AM (13.60)</td>
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</table>

**ANCILLARY RESULTS [AP Spine]**

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm²)</th>
<th>Young-Adult (%)</th>
<th>T-score</th>
<th>Age-Matched (%)</th>
<th>Z-score</th>
<th>BMC (g)</th>
<th>Area (cm²)</th>
<th>Width (cm)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>1.160</td>
<td>103</td>
<td>0.3</td>
<td>102</td>
<td>0.1</td>
<td>12.11</td>
<td>10.44</td>
<td>3.4</td>
<td>3.11</td>
</tr>
<tr>
<td>L2</td>
<td>1.214</td>
<td>101</td>
<td>0.1</td>
<td>100</td>
<td>0.0</td>
<td>12.74</td>
<td>10.50</td>
<td>3.4</td>
<td>3.09</td>
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<tr>
<td>L3</td>
<td>1.283</td>
<td>107</td>
<td>0.7</td>
<td>106</td>
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<td>14.87</td>
<td>11.59</td>
<td>3.6</td>
<td>3.26</td>
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<tr>
<td>L4</td>
<td>1.326</td>
<td>111</td>
<td>1.1</td>
<td>109</td>
<td>1.0</td>
<td>17.27</td>
<td>13.02</td>
<td>3.8</td>
<td>3.43</td>
</tr>
<tr>
<td>L1-L2</td>
<td>1.187</td>
<td>102</td>
<td>0.2</td>
<td>101</td>
<td>0.1</td>
<td>24.86</td>
<td>20.94</td>
<td>3.4</td>
<td>6.19</td>
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<td>L1-L3</td>
<td>1.221</td>
<td>104</td>
<td>0.4</td>
<td>103</td>
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<td>32.53</td>
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<td>9.45</td>
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<td>105</td>
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<td>45.55</td>
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<td>103</td>
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<td>27.61</td>
<td>22.09</td>
<td>3.5</td>
<td>6.34</td>
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<td>0.7</td>
<td>105</td>
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<td>9.77</td>
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<tr>
<td>L3-L4</td>
<td>1.306</td>
<td>109</td>
<td>0.9</td>
<td>108</td>
<td>0.8</td>
<td>32.14</td>
<td>24.61</td>
<td>3.7</td>
<td>6.69</td>
</tr>
</tbody>
</table>

Need to have less than 1SD of difference between the T scores of the levels reported.

When there is a significant level to level variation in the spine select the levels with the lower reading.

Must have 2 or more adjacent vertebrae, or exclude spine all together.

If need to exclude spine use the macro “DEXA Bad Lx”
Template “DEXA”

**TECHNIQUE:**

[Moores: General Electric Lunar Prodigy Advance.]
[Lewis: General Electric Lunar Prodigy.]

**COMPARISON:**

None.

**FINDINGS:**

LUMBAR SPINE([Insert appropriate levels]):
The bone mineral density is [ ] gm/cm sq.
Percentage of young normal mean is [ ]%.
T-score is [ ].
Percentage age-matched mean is [ ]%.
Z-score is [ ].

**IMPRESSION:**

According to the World Health Organization and National Osteoporosis Foundation the classification is, [insert lowest of T-score equivalent][normal, Osteoporosis, Low bone mass, Normal]

Please contact Dr. Tudor Hughes with any question regarding this study at pager: 0408

**CONCURRENT SUPERVISION:**

I have reviewed the images and agree with the Fellow's interpretation.
Bone Densitometry

- In preventing Fxs it is the worst scenario that matters.

- Generally a slight increase in density as descend the L spine.

- Approx 6% increase between L1 and L4.

**ANCILLARY RESULTS [AP Spine]**

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<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm²)</th>
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<th>Width (cm)</th>
<th>Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
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<td>124</td>
<td>2.3</td>
<td>120</td>
<td>2.0</td>
<td>8.92</td>
<td>6.22</td>
<td>2.2</td>
<td>2.79</td>
</tr>
<tr>
<td>L2</td>
<td>1.983</td>
<td>160</td>
<td>6.2</td>
<td>156</td>
<td>5.9</td>
<td>24.44</td>
<td>12.33</td>
<td>3.6</td>
<td>3.46</td>
</tr>
<tr>
<td>L3</td>
<td>1.001</td>
<td>81</td>
<td>-2.0</td>
<td>79</td>
<td>-2.3</td>
<td>15.04</td>
<td>15.03</td>
<td>4.1</td>
<td>3.66</td>
</tr>
<tr>
<td>L4</td>
<td>0.937</td>
<td>76</td>
<td>-2.5</td>
<td>74</td>
<td>-2.8</td>
<td>16.51</td>
<td>17.62</td>
<td>4.8</td>
<td>3.69</td>
</tr>
<tr>
<td>L3-L4</td>
<td>0.966</td>
<td>78</td>
<td>-2.3</td>
<td>76</td>
<td>-2.6</td>
<td>31.55</td>
<td>32.65</td>
<td>4.4</td>
<td>7.35</td>
</tr>
</tbody>
</table>
Bone Densitometry
DEXA spine check list

- Look for significant level to level variations

- 1 T-score or 15-20% difference between adjacent levels don’t include

- Use the macro “DEXA Bad Lx”

### ANCILLARY RESULTS [AP Spine]

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</tr>
<tr>
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<td>6.2</td>
<td>156</td>
<td>5.9</td>
<td>24.44</td>
<td>12.33</td>
<td>3.6</td>
<td>3.46</td>
</tr>
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<td>L3</td>
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<td>81</td>
<td>-2.0</td>
<td>79</td>
<td>-2.3</td>
<td>15.04</td>
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<td>74</td>
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<td>16.51</td>
<td>17.62</td>
<td>4.8</td>
<td>3.69</td>
</tr>
<tr>
<td>L3-L4</td>
<td>0.966</td>
<td>78</td>
<td>-2.3</td>
<td>76</td>
<td>-2.6</td>
<td>31.55</td>
<td>32.65</td>
<td>4.4</td>
<td>7.35</td>
</tr>
</tbody>
</table>
What’s wrong with this scan?

Divisions don’t account for scoliosis
What's wrong with this scan?

### Bone Results

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD</th>
<th>T Score</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>0.898</td>
<td>-1.94</td>
<td>-1.07</td>
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<tr>
<td>L2</td>
<td>0.939</td>
<td>-2.18</td>
<td>-1.31</td>
</tr>
<tr>
<td>L3</td>
<td>1.246</td>
<td>0.38</td>
<td>1.25</td>
</tr>
<tr>
<td>L4</td>
<td>1.114</td>
<td>-0.72</td>
<td>0.15</td>
</tr>
<tr>
<td>L1-L2</td>
<td>0.922</td>
<td>-1.90</td>
<td>-1.03</td>
</tr>
<tr>
<td>L1-L3</td>
<td>1.084</td>
<td>-0.71</td>
<td>0.15</td>
</tr>
<tr>
<td>L1-L4</td>
<td>1.091</td>
<td>-0.74</td>
<td>0.13</td>
</tr>
<tr>
<td>L2-L3</td>
<td>1.132</td>
<td>-0.57</td>
<td>0.30</td>
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<tr>
<td>L2-L4</td>
<td>1.127</td>
<td>-0.61</td>
<td>0.26</td>
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<tr>
<td>L3-L4</td>
<td>1.195</td>
<td>-0.04</td>
<td>0.83</td>
</tr>
</tbody>
</table>

**DEXA Calibration**

- **BMD** (Bone Mineral Density) in g/cm²
- **T Score**
- **Z Score**

---

**Keys**:
- F1 - Verify Values
- F2 - Auto Analysis
- F3 - Manual Analysis
- F4 - Change Headings
- F5 - Select Calibration
- F6 - Compare Scans
- F11 - Select
- Esc - Next
- Home - Previous

**Image Not for Diagnosis**
ISCD
Spine Region of Interest (ROI)

- Use PA L1-L4 for spine BMD measurement
- Use all evaluable vertebrae and only exclude vertebrae that are affected by local structural change or artifact. Use three vertebrae if four cannot be used and two if three cannot be used.
- BMD based diagnostic classification should not be made using a single vertebra.
- If only one evaluable vertebra remains after excluding other vertebrae, diagnosis should be based on a different valid skeletal site (Hip and or Forearm).
- Anatomically abnormal vertebrae may be excluded from analysis if:
  - They are clearly abnormal and non-assessable within the resolution of the system; or
  - There is more than a 1.0 T-score difference between the vertebra in question and adjacent vertebrae.
- When vertebrae are excluded, the BMD of the remaining vertebrae is used to derive the T-score.
- The lateral spine should not be used for diagnosis, but may have a role in monitoring.
DEXA Femur check list
Hints for a good scan.

• Patient should be straight on table.

• Pack patient with rice bags.

• Shaft of femur should be straight.

• Rotate leg inward, this will hide the lesser trochanter.
Use the Neck unless T-score femur total is lower than femur neck, then use total.
Normal Hip

### ANCILLARY RESULTS [Left Femur]

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm²)</th>
<th>Young-Adult (%)</th>
<th>T-score</th>
<th>Age-Matched (%)</th>
<th>Z-score</th>
<th>BMC (g)</th>
<th>Area (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>0.971</td>
<td>94</td>
<td>-0.5</td>
<td>97</td>
<td>-0.2</td>
<td>4.27</td>
<td>4.40</td>
</tr>
<tr>
<td>Upper Neck</td>
<td>0.811</td>
<td>99</td>
<td>-0.1</td>
<td>99</td>
<td>-0.1</td>
<td>1.75</td>
<td>2.15</td>
</tr>
<tr>
<td>Lower Neck</td>
<td>1.125</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.52</td>
<td>2.24</td>
</tr>
<tr>
<td>Wards</td>
<td>0.793</td>
<td>87</td>
<td>-0.9</td>
<td>89</td>
<td>-0.8</td>
<td>1.70</td>
<td>2.14</td>
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<tr>
<td>Troch</td>
<td>0.798</td>
<td>94</td>
<td>-0.5</td>
<td>95</td>
<td>-0.4</td>
<td>9.69</td>
<td>12.15</td>
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<tr>
<td>Shaft</td>
<td>1.256</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.65</td>
<td>12.46</td>
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<tr>
<td>Total</td>
<td>1.021</td>
<td>101</td>
<td>0.1</td>
<td>102</td>
<td>0.2</td>
<td>29.61</td>
<td>29.00</td>
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</table>
Template “DEXA”

Repeat contralateral side

LEFT FEMUR ([Neck][Total]):
The bone mineral density is [ ] gm/cm sq.
Percentage of young normal mean is [ ]%.
T-score is [ ].
Percentage age-matched mean is [ ]%.
Z-score is [ ].

IMPRESSION:
According to the World Health Organization and National Osteoporosis Foundation the classification is, [insert lowest of T-score equivalent: Osteopenia, Osteoporosis, Low bone mass, Normal]

Please contact Dr. Tudor Hughes with any question regarding this study at pager: 0408

CONCURRENT SUPERVISION:
I have reviewed the images and agree with the Fellow’s interpretation.
DEXA Femur check list
Hints for a good scan.

- The Wards area is roughly half the neck area
- Trochanteric area 8-14cm² in women, 10-16cm² in men
- Check left and right and state side being used in report.
DEXA Femur check list
Hints for a good scan.

- The Wards area is roughly half the neck area
- Trochanteric area 8-14cm$^2$ in women, 10-16cm$^2$ in men
- Check left and right and state side being used in report.

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm$^2$)</th>
<th>Young-Adult (%)</th>
<th>T-Score</th>
<th>Age-Matched (%)</th>
<th>Z-Score</th>
<th>BMC (g)</th>
<th>Area (cm$^2$)</th>
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<tbody>
<tr>
<td>Neck</td>
<td>0.756</td>
<td>73</td>
<td>-2.0</td>
<td>90</td>
<td>-0.6</td>
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<td>Upper Neck</td>
<td>0.539</td>
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<td>81</td>
<td>-1.1</td>
<td>1.39</td>
<td>2.58</td>
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<tr>
<td>Lower Neck</td>
<td>0.966</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.57</td>
<td>2.66</td>
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<tr>
<td>Wards</td>
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<td>69</td>
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<td>94</td>
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<td>1.90</td>
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<td>Troch</td>
<td>0.657</td>
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<td>90</td>
<td>-0.6</td>
<td>6.65</td>
<td>10.12</td>
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<tr>
<td>Shaft</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>14.75</td>
<td>14.86</td>
</tr>
<tr>
<td>Total</td>
<td>0.839</td>
<td>83</td>
<td>-1.3</td>
<td>98</td>
<td>-0.1</td>
<td>25.37</td>
<td>30.22</td>
</tr>
</tbody>
</table>
What’s wrong with this scan?

Too much shaft
What's wrong with this scan?

**Insufficient tissue below Neck**

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD</th>
<th>T Score</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>NECK</td>
<td>0.699</td>
<td>-2.34</td>
<td>-1.98</td>
</tr>
</tbody>
</table>

**Bone Results**

**DEXA Calibration**

**LUNAR®**

F1 - Verify Values  F4 - Change Headings  T1 - Select
F2 - Auto Analysis  F5 - Select Calibration  Esc - Next
F3 - Manual Analysis F6 - Compare Scans  Home - Previous
What’s wrong with this scan?

Bone Results

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm²)</th>
<th>T Score</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>NECK</td>
<td>0.025</td>
<td>-7.96</td>
<td>-7.28</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.981</td>
<td>-0.16</td>
<td>0.36</td>
</tr>
</tbody>
</table>

Insufficient Pelvis separation
Insufficient tissue above Neck

Set up for wrong leg
What's wrong with this scan?

![Bone Scan Image]

**Bone Results**

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm²)</th>
<th>T Score</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>NECK</td>
<td>0.626</td>
<td>-2.95</td>
<td>-1.03</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.591</td>
<td>-3.41</td>
<td>-1.67</td>
</tr>
</tbody>
</table>

Includes ischium

**Insufficient Pelvis separation**

- F1 - Verify Values
- F2 - Auto Analysis
- F3 - Manual Analysis
- F4 - Change Headings
- F5 - Select Calibration
- F6 - Compare Scans
- 11 - Select
- Esc - Next
- Home - Previous
ISCD
Hip ROI

• Use femoral neck, or total proximal femur whichever is lowest.

• BMD may be measured at either/both hip(s)

• There are insufficient data to determine whether mean T-scores for bilateral hip BMD can be used for diagnosis

• The mean hip BMD can be used for monitoring, with total hip being preferred
Indications for Forearm DEXA 33%

- Hip and/or spine cannot be measured or interpreted
- In Hyperparathyroidism
- Very obese patients (over the weight limit for DEXA table).
ISCD
Forearm ROI

- Use 33% radius (sometimes called one-third radius) of the non-dominant forearm for diagnosis. Other forearm ROI are not recommended
## Normal Radius 33% Ancillary Results

### Data Summary
- **Height / Weight:** 64.0 in. 186.0 lbs.
- **Sex / Ethnic:** Female White
- **Measured:** 06/23/2016 10:23:53 AM (13.60)
- **Analyzed:** 06/23/2016 10:28:08 AM (13.60)

### Ancillary Results [Left Forearm]

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm²)</th>
<th>Young-Adult T-score</th>
<th>Age-Matched Z-score</th>
<th>BMC (g)</th>
<th>Area (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radius UD</td>
<td>0.375</td>
<td>99</td>
<td>-0.1</td>
<td>1.38</td>
<td>3.69</td>
</tr>
<tr>
<td>Ulna UD</td>
<td>0.300</td>
<td>-</td>
<td>-</td>
<td>0.65</td>
<td>2.18</td>
</tr>
<tr>
<td><strong>Radius 33%</strong></td>
<td><strong>0.670</strong></td>
<td><strong>94</strong></td>
<td><strong>-0.6</strong></td>
<td><strong>1.87</strong></td>
<td><strong>2.79</strong></td>
</tr>
<tr>
<td>Ulna 33%</td>
<td>0.790</td>
<td>-</td>
<td>-</td>
<td>1.69</td>
<td>2.14</td>
</tr>
<tr>
<td>Both UD</td>
<td>0.347</td>
<td>-</td>
<td>-</td>
<td>2.04</td>
<td>5.87</td>
</tr>
<tr>
<td>Both 33%</td>
<td>0.722</td>
<td>-</td>
<td>-</td>
<td>3.56</td>
<td>4.93</td>
</tr>
<tr>
<td>Radius Total</td>
<td>0.544</td>
<td>99</td>
<td>-0.1</td>
<td>7.70</td>
<td>14.16</td>
</tr>
<tr>
<td>Ulna Total</td>
<td>0.557</td>
<td>-</td>
<td>-</td>
<td>5.52</td>
<td>9.91</td>
</tr>
<tr>
<td>Both Total</td>
<td>0.549</td>
<td>-</td>
<td>-</td>
<td>13.22</td>
<td>24.07</td>
</tr>
</tbody>
</table>
### Template DEXA Radius 33%

<table>
<thead>
<tr>
<th>EXAM DESCRIPTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Procedure Description]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLINICAL HISTORY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Osteoporosis screening]</td>
</tr>
</tbody>
</table>

**RIGHT RADIUS (33%)**:
The bone mineral density is [ ] gm/cm sq.
Percentage of young normal mean is [ ]%.
T-score is [ ].
Percentage age-matched mean is [ ]%.
Z-score is [ ].

World Health Organization and National Osteoporosis Foundation Classification is [ ].

World Health Organization and National Osteoporosis Foundation Classification is [ ].

<table>
<thead>
<tr>
<th>IMPRESSION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>According to the World Health Organization and National Osteoporosis Foundation classification, this patient’s right radius 33% is [ ].</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONCURRENT SUPERVISION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[I have reviewed the images and agree with the fellow's interpretation.]</td>
</tr>
</tbody>
</table>
Bone Densitometry

- **Spine T score** is compared to reference population, 20-29 years, female, white.

  - Hip uses NHANES III
  - Spine manufacturer specific

- **Z score** is matched for age, sex, weight and ethnicity.
Bone Densitometry
WHO uses T scores

- Normal
  - > -1 SD below young adult

- Low bone mass/density (Osteopenia)
  - -1 - 2.49 SD

- Osteoporosis
  - <= -2.5 SD

- Established (Manifest) Osteoporosis
  - + Fxs, usually spine, hip, proximal humerus, wrist, rib

Post and perimenopausal women and men over 50 only
Premenopausal Women and Men < 50

- Use Z scores

- $Z \leq -2.0$
  - “below the expected range for age”

- $Z > -2.0$
  - “within the expected range for age”
Bone Densitometry

- Never round up figures
  - -0.99 is “normal”
  - -1 is “low bone mass”
  - -2.49 is “low bone mass”
  - -2.5 is “osteoporosis”,
Template “DEXA”

RIGHT FEMUR ([Neck][Total]):
The bone mineral density is [] gm/cm sq.
Percentage of young normal mean is []%.
T-score is [].
Percentage age-matched mean is []%.
Z-score is [].

IMPRESSION:

According to the World Health Organization and National Osteoporosis Foundation the classification is, [insert lowest of T-score equivalent wordage: Osteoporosis, Low bone mass, Normal]

Please contact Dr. Tudor Hughes with any question regarding this study at pager: 0408

Choose the lowest T score

LUMBAR SPINE([Insert appropriate levels]):
The bone mineral density is [] gm/cm sq.
Percentage of young normal mean is []%.
T-score is [].
Percentage age-matched mean is []%.
Z-score is [].
Follow Up

- Intervals between BMD testing should be determined according to each patient’s clinical status: typically one year after initiation or change of therapy is appropriate, with longer intervals once therapeutic effect is established.

- In conditions associated with rapid bone loss, such as glucocorticoid therapy, testing more frequently is appropriate.
Bone Densitometry
Comparison with previous

- Are the studies comparable
  
- Always compare like with like
  - Thornton L1-4
  - 4th and Lewis (previously L2-4)

- Any intervening events

- Cannot compare Hologic and Lunar

- Cannot compare Thornton and Hillcrest

- We try to have follow up scans at same location as prior
Bone Densitometry
Comparison with previous

- If over a period of time there is an increase in BMD in the lower lumbar spine and decrease in the upper lumbar spine, it is likely there is OA of the lower facet joints, and the upper lumbar spine is a truer reflection of useful BMD.
Bone Densitometry
Comparison with previous

- Increase in BMD of the femoral neck can be due to calcar buttressing with OA of the hip.
Bone Densitometry Comparison with previous

- If you want to eyeball the % for a comparison, use the young adult % since the reference range will not change with age.

### ANCILLARY RESULTS [AI]

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (^1) ((g/cm^2)</th>
<th>Measured Date</th>
<th>Age (years)</th>
<th>BMD ((g/cm^2)</th>
<th>Trend: L2-L4 (^1)</th>
<th>Change vs Baseline (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>1.230</td>
<td>06/24/2016</td>
<td>47.5</td>
<td>1.529</td>
<td>4.2 *</td>
<td>4.1</td>
</tr>
<tr>
<td>L2</td>
<td>1.464</td>
<td>07/30/2015</td>
<td>46.6</td>
<td>1.467</td>
<td>-0.3</td>
<td>3.4</td>
</tr>
<tr>
<td>L3</td>
<td>1.555</td>
<td>08/14/2014</td>
<td>45.6</td>
<td>1.472</td>
<td>3.7 *</td>
<td>3.7</td>
</tr>
<tr>
<td>L4</td>
<td>1.556</td>
<td>06/26/2013</td>
<td>44.5</td>
<td>1.419</td>
<td>-</td>
<td>baseline</td>
</tr>
<tr>
<td>L1-L2</td>
<td>1.342</td>
<td>121</td>
<td>2.0</td>
<td>124</td>
<td>1.7</td>
<td>3.7</td>
</tr>
<tr>
<td>L1-L3</td>
<td>1.415</td>
<td>123</td>
<td>2.3</td>
<td>127</td>
<td>2.3</td>
<td>3.7</td>
</tr>
<tr>
<td>L1-L4</td>
<td>1.457</td>
<td>126</td>
<td>2.6</td>
<td>129</td>
<td>2.8</td>
<td>3.7</td>
</tr>
<tr>
<td>L2-L3</td>
<td>1.511</td>
<td>127</td>
<td>2.7</td>
<td>131</td>
<td>3.0</td>
<td>3.8</td>
</tr>
<tr>
<td>L2-L4</td>
<td>1.529</td>
<td>130</td>
<td>3.0</td>
<td>133</td>
<td>3.2</td>
<td>3.8</td>
</tr>
<tr>
<td>L3-L4</td>
<td>1.555</td>
<td>130</td>
<td>3.0</td>
<td>133</td>
<td>3.2</td>
<td>3.9</td>
</tr>
</tbody>
</table>
Bone Densitometry
Comparison with previous

- If you would have expected the bone density to have fallen 4% in 2 years, and it is static, then this is a positive response to RX
Bone Densitometry Comparison with previous

• Generally Rx affects all levels equally.

• OA does not.
Total hip is preferred for monitoring, no matter if total is denser than neck.

So report lower of “total” or “neck” in measurements and “total” in comparison.
Femur
Selecting area to measure

• Always explain any variation in reading technique from the previous study.

• Watch out for the * that denotes a significant change from prior.

<table>
<thead>
<tr>
<th>Measured Date</th>
<th>Age (years)</th>
<th>BMD (g/cm²)</th>
<th>Trend: L2-L4</th>
<th>Change vs Baseline (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/24/2016</td>
<td>47.5</td>
<td>1.529</td>
<td></td>
<td>4.2 *</td>
</tr>
<tr>
<td>07/30/2015</td>
<td>46.6</td>
<td>1.467</td>
<td></td>
<td>-0.3</td>
</tr>
<tr>
<td>08/14/2014</td>
<td>45.6</td>
<td>1.472</td>
<td></td>
<td>3.7 *</td>
</tr>
<tr>
<td>06/26/2013</td>
<td>44.5</td>
<td>1.419</td>
<td></td>
<td>3.8 *</td>
</tr>
</tbody>
</table>

1 BMD = Bone Mineral Density
### AP Spine Bone Density Trend

**Densitometry Ref:** L2-L4 (BMD)  
**Trend:** L2-L4 (BMD)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>BMD (g/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>1.68</td>
</tr>
<tr>
<td>30</td>
<td>1.56</td>
</tr>
<tr>
<td>40</td>
<td>1.44</td>
</tr>
<tr>
<td>50</td>
<td>1.32</td>
</tr>
<tr>
<td>60</td>
<td>1.20</td>
</tr>
<tr>
<td>70</td>
<td>1.08</td>
</tr>
<tr>
<td>80</td>
<td>0.96</td>
</tr>
<tr>
<td>90</td>
<td>0.84</td>
</tr>
<tr>
<td>100</td>
<td>0.72</td>
</tr>
</tbody>
</table>

**Trend vs Baseline**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>%Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>-2.0</td>
</tr>
<tr>
<td>30</td>
<td>-4.0</td>
</tr>
<tr>
<td>40</td>
<td>-6.0</td>
</tr>
<tr>
<td>50</td>
<td>-8.0</td>
</tr>
<tr>
<td>60</td>
<td>-10.0</td>
</tr>
<tr>
<td>70</td>
<td>-12.0</td>
</tr>
<tr>
<td>80</td>
<td>-14.0</td>
</tr>
<tr>
<td>90</td>
<td>-16.0</td>
</tr>
<tr>
<td>100</td>
<td>-18.0</td>
</tr>
</tbody>
</table>

**Region**

- L1: 1.230
- L2: 1.464
- L3: 1.555
- L4: 1.556
- L1-L4: 1.457
- L2-L4: 1.529

**Young-Adult T-score**

- L1: 0.8
- L2: 2.2
- L3: 3.0
- L4: 3.0
- L1-L4: 2.3
- L2-L4: 2.7

**Age-Matched Z-score**

- L1: 1.1
- L2: 2.5
- L3: 3.2
- L4: 3.2
- L1-L4: 2.6
- L2-L4: 3.0

### Trend: L2-L4

<table>
<thead>
<tr>
<th>Measured Date</th>
<th>Age (years)</th>
<th>BMD (g/cm²)</th>
<th>Change vs Baseline (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/24/2016</td>
<td>47.5</td>
<td>1.529</td>
<td>4.2 *</td>
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<tr>
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<td>46.6</td>
<td>1.467</td>
<td>-0.3 *</td>
</tr>
<tr>
<td>08/14/2014</td>
<td>45.6</td>
<td>1.472</td>
<td>3.7 *</td>
</tr>
<tr>
<td>06/26/2013</td>
<td>44.5</td>
<td>1.419</td>
<td>- baseline</td>
</tr>
</tbody>
</table>

**Comments:** F/U 2015  
POST LUNG TRANSPLANT  
ON PREDNISONE  
NANCY

---

* - Indicates significant change based on 95% confidence interval.

1. Statistically 68% of repeat scans fall within 1SD (+ 0.010 g/cm² for AP Spine L2-L4)  
2. USA (Combined NHANES [ages 20-30]) Lunar (ages 20-40) AP Spine Reference Population (v112)  
3. Matched for Age, Weight (females 25-100 lb), Ethnic

11. World Health Organization - Definition of Osteoporosis and Osteopenia for Caucasian Women:  
Normal = T-score at or above -1.0 SD; Osteopenia = T-score between -1.0 and -2.5 SD;  
Osteoporosis = T-score at or below -2.5 SD (WHO definition only applies when a young healthy Caucasian women reference database is used to determine T-scores).
Height / Weight: 67.0 in. 140.0 lbs.
Sex / Ethnic: Female White

Densitometry Ref: Neck (BMD)
BMD (g/cm²) | T-score | Trend: Neck (BMD)
---|---|---
1.316 | Normal | 0.0
1.177 |
1.038 |
0.909 |
0.899 |
0.899 |
0.821 |
0.621 |
0.482 |
0.343 |

Region | BMD (g/cm²) | Young-Adult | Age-Matched
---|---|---|---
Neck | 1.041 | 0.0 | 0.7
Total | 0.980 | -0.2 | 0.2

Hip Axis Length Comparison (mm)

Trend: Neck

Measured Date | Age (years) | BMD (g/cm²) | Previous (%) | Change vs Baseline (%)
---|---|---|---|---
06/24/2016 | 47.5 | 1.041 | 3.3 | 4.6 *
07/30/2015 | 46.6 | 1.008 | 0.1 | 1.3
08/14/2014 | 45.6 | 1.007 | 1.2 | 1.2
06/26/2013 | 44.5 | 0.995 | - | baseline

Comments: F/U 2015
POST LUNG TRANSPLANT
ON PREDNISONE
NANCY
This new page in PACS helps separate “Neck” and “Total”
DEXA FU

RIGHT FEMUR ([Neck][Total]):
The bone mineral density is [] gm/cm sq.
Percentage of young normal mean is []%.
T-score is [].
Percentage age-matched mean is []%.
Z-score is [].

COMMENT:
The right femur total demonstrates an interval change of []% from the most recent previous study of [], which is [not] a statistically significant change and an interval change of []% from the baseline study of [], which is [not] a statistically significant change.

LEFT FEMUR ([Neck][Total]):
The bone mineral density is [] gm/cm sq.
Percentage of young normal mean is []%.
T-score is [].
Percentage age-matched mean is []%.
Z-score is [].

COMMENT:
The left femur total demonstrates an interval change of []% from the most recent previous study of [], which is [not] a statistically significant change and an interval change of []% from the baseline study of [], which is [not] a statistically significant change.

LUMBAR SPINE([Insert appropriate levels]):
The bone mineral density is [] gm/cm sq.
Percentage of young normal mean is []%.
T-score is [].
Percentage age-matched mean is []%.
Z-score is [].

COMMENT:
The lumbar spine [Insert appropriate levels] demonstrates an interval change of []% from the most recent previous study of [], which is [not] a statistically significant change and an interval change of []% from the baseline study of [], which is [not] a statistically significant change.
<table>
<thead>
<tr>
<th>IMPRESSION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>According to the World Health Organization and National Osteoporosis Foundation the classification is [insert lowest of T-score equivalent wordage: Osteoporosis, Low bone mass, Normal]</td>
</tr>
<tr>
<td>In comparison with the most recent previous study of [] there has been a percentage [increase/decrease] that is greatest at the [X] of [], which is [not] a statistically significant change and from the baseline study of [], that is greatest at the [X] of [], which is [not] a statistically significant change.</td>
</tr>
<tr>
<td>[]</td>
</tr>
<tr>
<td>Please contact Dr. Tudor Hughes with any question regarding this study at pager: 0408</td>
</tr>
</tbody>
</table>

Select worse case scenario for current and comparison

If there is no * next to the % change, please just use the wordage “No significant change”.
Serial BMD Measurements

- Serial BMD testing can be used to determine whether treatment should be started on untreated patients, because significant loss may be an indication for treatment.

- Serial BMD testing can monitor response to therapy by finding an increase or stability of bone density.

- Serial BMD testing can evaluate individuals for non-response by finding loss of bone density, suggesting the need for reevaluation of treatment and evaluation for secondary causes of osteoporosis.

- Follow-up BMD testing should be done when the expected change in BMD equals or exceeds the least significant change (LSC).
Bone mass in healthy children
Bone mass in healthy children

- Increases with age, weight and pubertal Tanner stage.

- **Tanner stage and weight** are best predictors of bone mass.

- Age, sex, race, activity and diet are not good predictors, when weight and Tanner stage are controlled.
• Make sure we have at least the age and weight of the child, if not the Tanner stage.
BMD in children and adolescents

Figure 1. Male and female spine BMD plotted by age.

Figure 2. Male and female femur neck BMD plotted by age.
Z-scores, not T-scores, are preferred. This is particularly important in children.

A Z-score of -2.0 or lower is defined as “below the expected range for age”

A Z-score above -2.0 is “within the expected range for age.”

Osteoporosis cannot be diagnosed in men under age 50 on the basis of BMD alone.

The WHO diagnostic criteria may be applied to women in the menopausal transition.
## EXAM DESCRIPTION:

[<Procedure Description>]  

## CLINICAL HISTORY:

[Osteoporosis screening]

## TECHNIQUE:

[Moore: General Electric Lunar Prodigy Advance.]
[Levis: General Electric Lunar Prodigy.]

## COMPARISON:

[]

## FINDINGS:

LUMBAR SPINE (L1-L4):
The bone mineral density is [] gm/cm sq.
Percentage age-matched mean is []%.
Z-score is [].
Due to patient age, T-score could not be calculated.

## IMPRESSION:

In comparison with age, weight, sex, and ethnicity matched children, this patient has [] standard deviations [less] bone density.

## CONCURRENT SUPERVISION:

[I have reviewed the images and agree with the fellow's interpretation.]
A distinction is made between diagnostic classification and the use of BMD for fracture risk assessment.

For fracture risk assessment, any well-validated technique can be used, including measurements of more than one site where this has been shown to improve the assessment of risk.
WHO Fracture Risk Algorithm (FRAX®)

- FRAX was developed to calculate the 10-year probability of a hip fracture and the 10-year probability of a major osteoporotic fracture (defined as clinical vertebral, hip, forearm or proximal humerus fracture)

- This takes into account femoral neck BMD and the clinical risk factors

- The FRAX® algorithm is available at www.nof.org
FRAX

• FRAX is intended for postmenopausal women and men age 50 and older.

• The FRAX tool has not been validated in patients currently or previously treated with pharmacotherapy for osteoporosis
FRAX

- FRAX can be calculated with either femoral neck BMD or total hip BMD but when available, femoral neck BMD is preferred.
Please remember that FRAX is only of use in patients who are of “low bone mass” and not on treatment for osteoporosis.
### FRAX print out

<table>
<thead>
<tr>
<th>Height / Weight:</th>
<th>60.5 in. 97.0 lbs.</th>
<th>Measured:</th>
<th>06/28/2016 2:04:12 PM (13.60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex / Ethnic:</td>
<td>Female White</td>
<td>Analyzed:</td>
<td>06/28/2016 2:06:08 PM (13.60)</td>
</tr>
</tbody>
</table>

**DualFemur FRAX**

#### Risk Factors:
- [x] None
- [ ] Alcohol (3 or more units per day)
- [ ] Family Hist. (Parent hip fracture)
- [ ] Glucocorticoids (Chronic)
- [ ] History of Fracture (Adult)
- [ ] Secondary Osteoporosis
- [ ] Rheumatoid Arthritis
- [ ] Tobacco User (Current Smoker)

#### 10-year Probability of Fracture:
- Major Osteoporotic: 11.2%
- Hip: 2.6%
- Population: USA (Caucasian)

Based on DualFemur (Left) Neck BMD
FRAX macro

- 10 year probability of fracture:
- Major osteoporotic: []%
- Hip: []%
- Population: USA (Caucasian)
- Based on DualFemur (left) neck BMD
Vertebral Fracture Assessment

• Nomenclature

• Vertebral Fracture Assessment (VFA) is the correct term to denote densitometric spine imaging performed for the purpose of detecting vertebral fractures.